

## AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

1-36. (Cancelled)

37. (Currently Amended) An aberration compensating optical element comprising:

a single lens, comprising:

a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps formed on a plane surface; and

a second optical surface opposite to the first optical surface, the second optical surface comprising a concave refractive surface;

~~The aberration compensating optical element of claim 36, wherein the single lens satisfies the following relation[[;]] :~~

$$P_{\lambda 1} < P_{\lambda 0} < P_{\lambda 2}$$

wherein  $P_{\lambda 0}$  represents a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a wavelength  $\lambda_0$  of a light flux, which passes through the single lens;  $P_{\lambda 1}$  represents a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a wavelength  $\lambda_1$ , which is 10 nm shorter than the wavelength  $\lambda_0$ ; and  $P_{\lambda 2}$  represents a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a wavelength  $\lambda_2$ , which is 10 nm longer than the wavelength  $\lambda_0$ .

38. (Currently Amended) An aberration compensating optical element comprising:

a single lens, comprising:

a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps formed on a plane surface; and

a second optical surface opposite to the first optical surface, the second optical surface comprising a concave refractive surface; ~~The aberration-compensating optical element of claim 36, wherein at least one ring-shaped zone step having a step distance  $\Delta$  (mm) in a direction of an optical axis between adjacent steps of the plurality of ring-shaped zone steps is formed within an effective diameter so that  $m$ , defined by the following equations, becomes an integer except 0 and  $\pm 1$ :~~

$$m = \text{INT}(Y),$$

$$Y = \Delta \times (n-1) / (\lambda_0 \times 10^{-3}),$$

wherein INT(Y) is an integer obtained by rounding Y;  $\lambda_0$  is the wavelength (nm) of a light flux, which passes through the single lens; and n is a refractive index of the single lens at the wave length  $\lambda_0$  (nm).

39. (Currently Amended) An aberration compensating optical element comprising:

a single lens, comprising:

a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps formed on a plane surface; and

a second optical surface opposite to the first optical surface, the second optical surface comprising a concave refractive surface; ~~The aberration-compensating optical element of claim 36,~~ wherein the single lens satisfies the following relation:

$$0.5 \times 10^{-2} < P_D < 15.0 \times 10^{-2},$$

wherein  $P_D$  is a paraxial power ( $\text{mm}^{-1}$ ) of the diffractive structure and is defined by the following equation:

$$P_D = \Sigma(-2 \cdot b_2 \cdot n),$$

when an optical path difference  $\Phi b$ , which is added to a wavefront transmitting through the single lens by the diffractive structure formed on the first optical surface of the single lens, is defined by the following wavefront transmitting function:

$$\Phi b = n \cdot (b_2 \cdot h^2 + b_4 \cdot h^4 + b_6 \cdot h^6 + \dots),$$

wherein  $h$  (mm) is a height from the optical axis; each of  $b_2$ ,  $b_4$ ,  $b_6 \dots$  is a second, fourth, sixth order coefficient of the optical path difference function, respectively; and  $n$  is a diffraction order of a diffracted light having a maximum diffracted light amount among a plurality of diffracted lights generated by the diffractive structure formed on the first optical surface of the single lens.

40. (Previously Presented) The aberration compensating optical element of claim 39, wherein the single lens satisfies the following relation:

$$1.0 \times 10^{-2} < P_D < 10.0 \times 10^{-2}.$$

41. (Currently Amended) An aberration compensating optical element comprising:

a single lens, comprising:

a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps formed on a plane surface; and

a second optical surface opposite to the first optical surface, the second optical surface comprising a concave refractive surface, and ~~The aberration-compensating optical element of claim 36,~~ wherein the single lens satisfies the following relations:

$$P_D > 0,$$

$$P_R < 0, \text{ and}$$

$$-0.9 < P_D/P_R < -1.1,$$

wherein  $P_D$  is a paraxial power ( $\text{mm}^{-1}$ ) of the diffractive structure and is defined by the following equation:

$$P_D = \Sigma(-2 \cdot b_2 \cdot n),$$

when an optical path difference  $\Phi b$ , which is added to a wavefront transmitting through the single lens by the diffractive structure formed on the first optical surface of the single lens, is defined by the following wavefront transmitting function,

$$\Phi b = n \cdot (b_2 \cdot h^2 + b_4 \cdot h^4 + b_6 \cdot h^6 + \dots),$$

wherein  $h$  (mm) is a height from the optical axis; each of  $b_2$ ,  $b_4$ ,  $b_6 \dots$  is a second, forth, sixth order coefficient of the optical path difference function, respectively; and  $n$  is a diffraction order of a diffracted light having a maximum diffracted light amount among a plurality of diffracted lights generated by the diffractive structure formed on the first

optical surface of the single lens, and  $P_R$  is a refractive power ( $\text{mm}^{-1}$ ) of the single lens as a refractive lens.

42. (Currently Amended) An aberration compensating optical element comprising:  
a single lens, comprising:  
a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps formed on a plane surface; and  
a second optical surface opposite to the first optical surface, the second optical surface comprising a concave refractive surface, and  
~~The aberration compensating optical element of claim 36,~~ wherein a paraxial power  $P_{\lambda 0}$  ( $\text{mm}^{-1}$ ) of the single lens is substantially zero at the wavelength  $\lambda_0$  of a light flux, which passes through the single lens.

43. (Currently Amended) An aberration compensating optical element comprising:  
a single lens, comprising:  
a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps formed on a plane surface; and  
a second optical surface opposite to the first optical surface, the second optical surface comprising a concave refractive surface;  
~~The aberration compensating optical element of claim 36,~~ wherein when a wavelength of a light flux

entering the diffractive structure is not more than 550 nm, a diffraction efficiency of the diffractive structure becomes maximal.

44. (Cancelled)

45. (Currently Amended) An aberration compensating optical element comprising:

a single lens, comprising:

a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps formed on a plane surface; and

a second optical surface opposite to the first optical surface, the second optical surface comprising a concave refractive surface; ~~The aberration-~~

~~compensating optical element of claim 36,~~ wherein the diffractive structure has such a spherical aberration property that a spherical aberration of an emergent light flux is changed in an under-corrected direction or an over-corrected direction when a wavelength of an incident light flux is shifted to a longer wavelength side, and

wherein the diffractive structure is formed so as to satisfy the following relation[[,]] :

$$0.2 \leq |(P_{hf}/P_{hm})-2| \leq 6.0;$$

wherein  $P_{hf}$  is a first interval in a direction [[to]] perpendicular to an optical axis of the diffractive structure between adjacent steps of the ring-shaped zones of the diffractive structure at a diameter  $hf$ , which is a half of a maximum effective diameter  $hm$ , and  $P_{hm}$  is a second interval in the direction [[to]] perpendicular to the optical axis of

the diffractive structure between adjacent steps of the ring-shaped zones of the diffractive structure at the maximum effective diameter  $hm$ .

46. (Cancelled)

47. (Currently Amended) An aberration compensating optical element comprising:

a single plastic lens, comprising a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps;

wherein the single lens satisfies the following relations:

$$P_{T1} < P_{T0} < P_{T2}$$

$$P_R < 0$$

$$0 < \Delta P_{AC} / \Delta T_{AC} < 1 \times 10^{-4};$$

wherein  $P_{T0}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a predetermined temperature  $T_0$ ;  $P_{T1}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_1$ , which is lower than the predetermined temperature  $T_0$ ;  $P_{T2}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_2$ , which is higher than the predetermined temperature  $T_0$ ;  $P_R$  is a refractive power ( $\text{mm}^{-1}$ ) of the single lens as a refractive lens; and The aberration-compensating optical element of claim 46, wherein the single lens satisfies the following relation,

$$0 < \Delta P_{AC} / \Delta T_{AC} < 1 \times 10^{-4}$$

wherein  $\Delta P_{AC}$  is an amount of a change in a paraxial power ( $\text{mm}^{-1}$ ) of the single lens, which is caused by the temperature change  $\Delta T_{AC}$  ( $^{\circ}\text{C}$ ) of the single lens.

48. (Cancelled)

49. (Currently Amended) An aberration compensating optical element comprising:

a single plastic lens, comprising a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps;

wherein the single lens satisfies the following relations:

$$P_{T1} < P_{T0} < P_{T2}$$

$$P_R < 0;$$

wherein  $P_{T0}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a predetermined temperature  $T_0$ ;  $P_{T1}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_1$ , which is lower than the predetermined temperature  $T_0$ ;  $P_{T2}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_2$ , which is higher than the predetermined temperature  $T_0$ ; and  $P_R$  is a refractive power ( $\text{mm}^{-1}$ ) of the single lens as a refractive lens, and ~~The aberration compensating optical element of claim 46, wherein a paraxial power  $P_{\lambda 0}$  ( $\text{mm}^{-1}$ ) of the single lens is substantially zero at the wavelength  $\lambda_0$  of a light flux, which passes through the single lens.~~

50. (Currently Amended) An aberration compensating optical element comprising:

a single plastic lens, comprising a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps;



wherein the single lens satisfies the following relations:

$$P_{T1} < P_{T0} < P_{T2}$$

$$P_R < 0;$$

wherein  $P_{T0}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a predetermined temperature  $T_0$ ;  $P_{T1}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_1$ , which is lower than the predetermined temperature  $T_0$ ;  $P_{T2}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_2$ , which is higher than the predetermined temperature  $T_0$ ; and  $P_R$  is a refractive power ( $\text{mm}^{-1}$ ) of the single lens as a refractive lens, and The aberration compensating optical element of claim 46, wherein at least one ring-shaped zone step having a step distance  $\Delta$  (mm) in a direction of an optical axis between adjacent steps of the plurality of ring-shaped zone steps is formed within an effective diameter so that  $m$ , defined by the following equations, becomes an integer except 0 and  $\pm 1$ :

$$m = \text{INT}(Y),$$

$$Y = \Delta \times (n-1) / (\lambda_0 \times 10^{-3}),$$

wherein  $\text{INT}(Y)$  is an integer obtained by rounding  $Y$ ;  $\lambda_0$  is the wavelength (nm) of a light flux, which passes through the single lens; and  $n$  is a refractive index of the single lens at the wave length  $\lambda_0$  (nm).

51. (Currently Amended) An aberration compensating optical element comprising:

a single plastic lens, comprising a first optical surface comprising a diffractive structure comprising a plurality of ring-shaped zone steps;

wherein the single lens satisfies the following relations:

$$P_{T1} < P_{T0} < P_{T2}$$

$$P_R < 0;$$

wherein  $P_{T0}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a predetermined temperature  $T_0$ ;  $P_{T1}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_1$ , which is lower than the predetermined temperature  $T_0$ ;  $P_{T2}$  is a paraxial power ( $\text{mm}^{-1}$ ) of the single lens at a temperature  $T_2$ , which is higher than the predetermined temperature  $T_0$ ; and  $P_R$  is a refractive power ( $\text{mm}^{-1}$ ) of the single lens as a refractive lens, and The aberration-compensating optical element of claim 46, wherein the diffractive structure has such a spherical aberration property that a spherical aberration of an emergent light flux is changed in an under-corrected direction or an over-corrected direction when a wavelength of an incident light flux is shifted to a longer wavelength side, and

wherein the diffractive structure is formed so as to satisfy the following relation[[,]] :

$$0.2 \leq |(P_{hf}/P_{hm})-2| \leq 6.0;$$

wherein  $P_{hf}$  is a first interval in a direction [[to]] perpendicular to an optical axis of the diffractive structure between adjacent steps of the ring-shaped zones of the diffractive structure at a diameter  $hf$ , which is a half of a maximum effective diameter  $hm$ , and  $P_{hm}$  is a second interval in the direction [[to]] perpendicular to the optical axis of the diffractive structure between adjacent steps of the ring-shaped zones of the diffractive structure at the maximum effective diameter  $hm$ .